

- [54] **PRINTER HEAD ASSEMBLY**
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which is a continuation of Ser. No. 37,815, May 15,
1970, abandoned.
[52] U.S. Cl..... **197/1 R**
[51] Int. Cl..... **B41j 3/10**
[58] Field of Search..... 197/1 R; 101/93 C

References Cited

UNITED STATES PATENTS

- | | | | |
|-----------|---------|--------------|-----------|
| 2,129,065 | 9/1938 | Loop..... | 197/1 R |
| 2,632,386 | 3/1953 | Hyland..... | 197/1 R X |
| 3,108,673 | 10/1963 | Green | 197/1 R |
| 3,333,667 | 8/1967 | Nordin | 197/1 R |
| 3,467,232 | 9/1969 | Paige..... | 197/1 R |

3,584,575 6/1971 Distl..... 197/1 R X
3,603,442 9/1971 Ward 197/1 R

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ABSTRACT

[57] A solenoid assembly for use in high speed printers of the dot matrix type wherein the solenoid construction is of such a design as to be extremely lightweight and capable of high speed operation so as to cooperate with the printer head assembly to provide a compact, lightweight design adapted to be moved at high rates of speed across a paper document. The solenoid armature is biased by a circular shaped biasing spring which is prevented from bending beyond its flat shape when it abuts against the interior surface of the solenoid assembly end cap.

3 Claims, 7 Drawing Figures

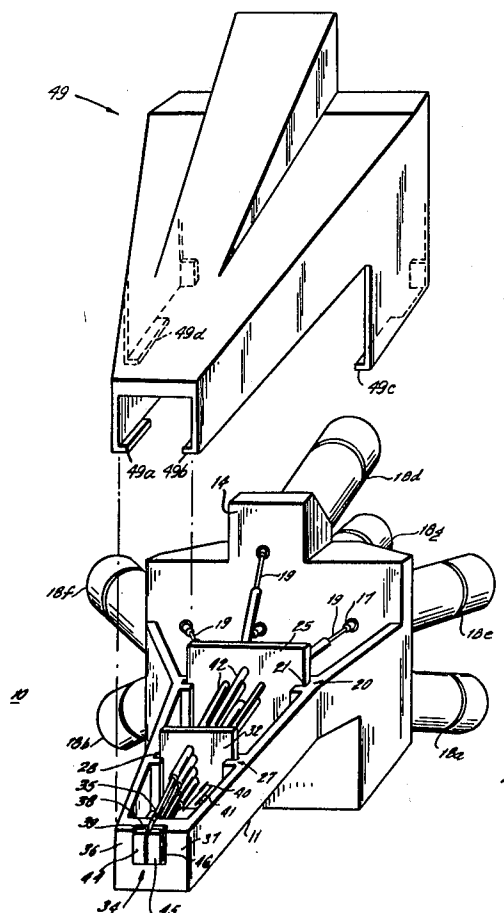


FIG. 1a.

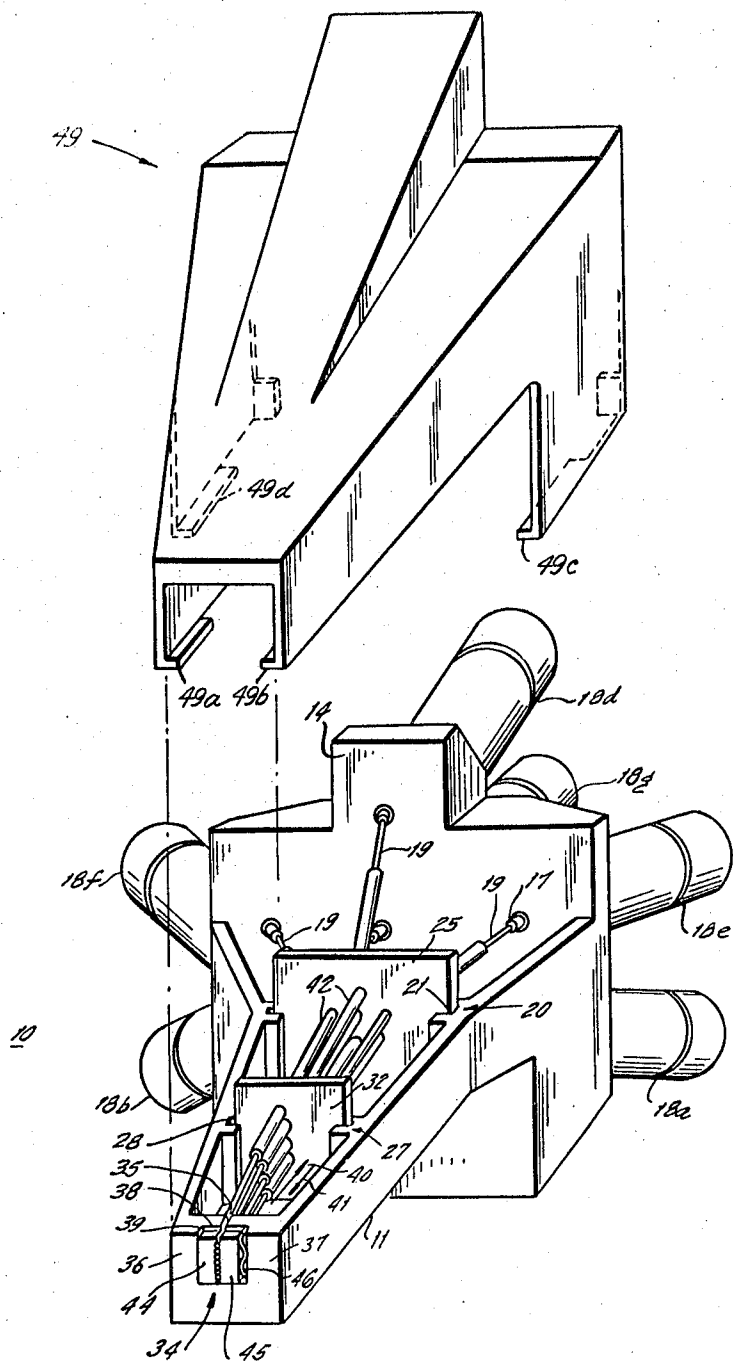


FIG. 1b.

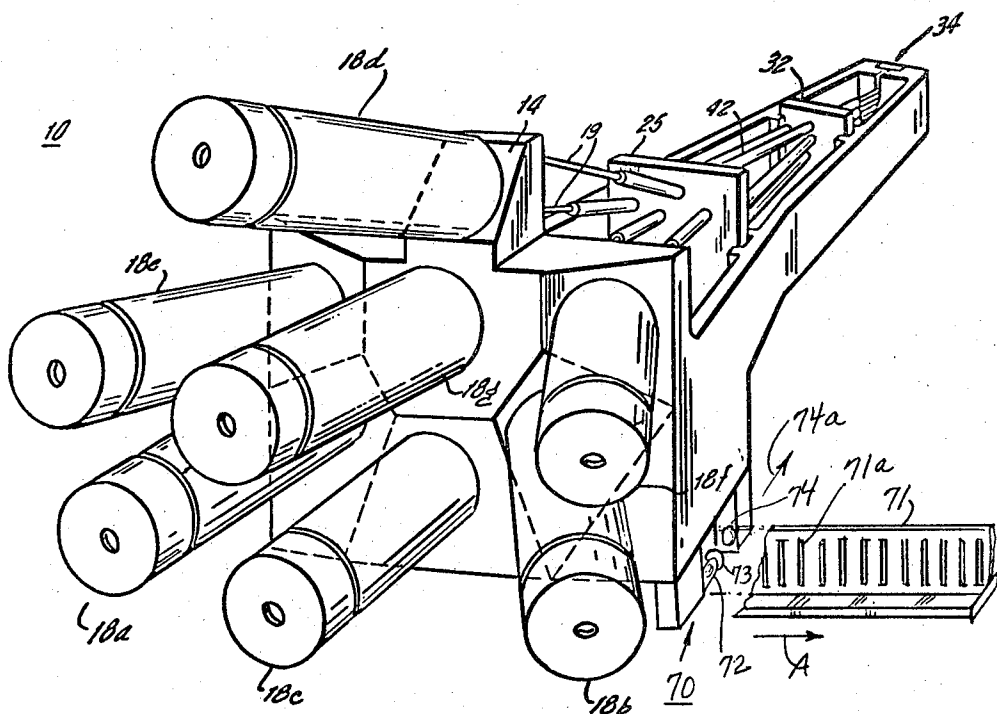
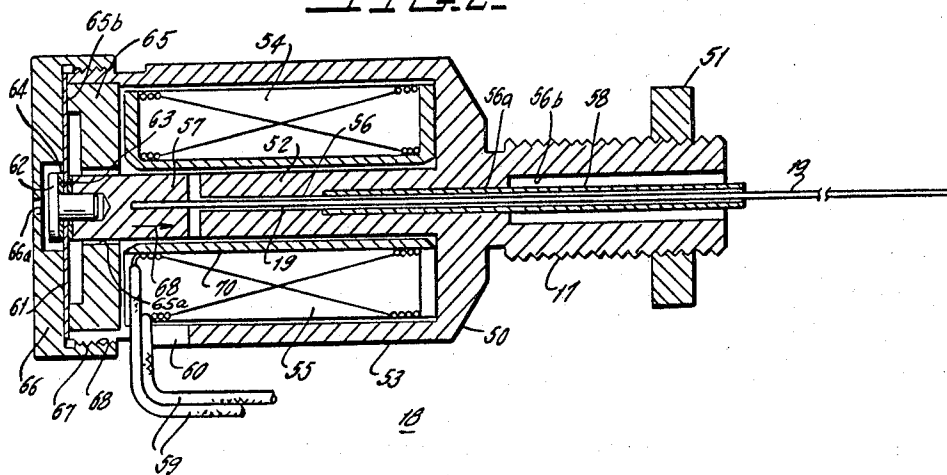
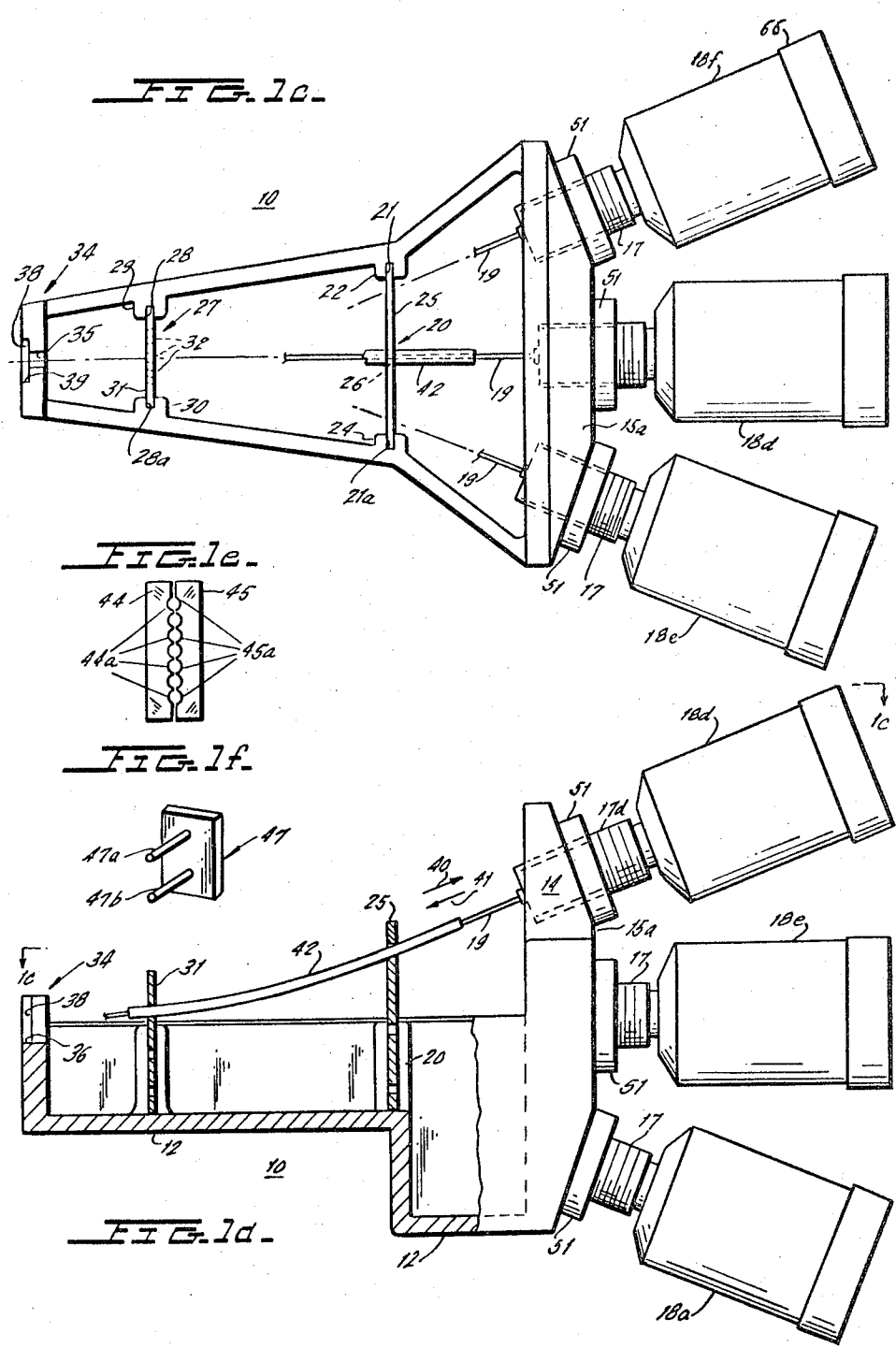


FIG. 2.





PRINTER HEAD ASSEMBLY

This is a continuation of application Ser. No. 179,457, filed Sept. 10, 1971 which, in turn, is a continuation of application Ser. No. 37,815 filed May 15, 1970, now abandoned.

The present invention relates to printers and more particularly to a novel printer head assembly and driving means therefor for use with high speed printers of the dot-matrix type.

Wire matrix printers are well known in the prior art. One of the earliest types of wire matrix printers is comprised of a plurality of wires arranged in matrix fashion for making impact through a ribbon to a paper document whereby the wires are selectively energized to form characters, numerals or other symbols. The earliest type of wire matrix printers were capable of printing either words or entire characters. The next development in the art consisted of wire matrix printers having a plurality of wires arranged in an M-row by N-column fashion. A typical arrangement for such wire matrix printers is to provide a total of 35 wires arranged in seven rows and five columns to print any character, number, or symbol. In operation, selected ones of the print wires are driven against the paper document to form the desired character or symbol. The print wires are then shifted one position to the right to print the next character whereby shifting occurs in an intermittent fashion. Since 35 separate mechanisms must be provided for each of the 35 print wires forming the 5 × 7 matrix, the amount of mass which must be moved to perform such printing is quite appreciable. This thereby resulted in the development of wire matrix type printers in which only seven print wires are employed. The print wires are typically arranged in a vertical line and are selectively driven against the paper document to form one of the five columns of the character. The carriage assembly which moves the print wire assembly is then shifted one position to the right to print the next column. This operation continues until all five columns have been printed to ultimately form the character or other symbol.

The present invention is characterized by providing solenoids for a high speed impact printer of the dot matrix type in which the printer head assembly is constantly moved across the paper document at speeds not heretofore capable of being achieved in present day systems.

The present invention is comprised of a printer head assembly having solenoid driven print wires. The entire printer head assembly, including the solenoid drivers, is moved across the paper document at a constant rate of speed. The arrangement of the printer head assembly is such as to provide a light weight compact structure so as to minimize the mass which is moved across the paper document, enabling the structure to move at relatively high speed.

The printer head assembly is comprised of a one-piece die cast housing having a rear wall which is bevelled to form a truncated pyramidal shape. The light weight high speed solenoid drivers are mounted through tapped apertures provided in each of the rear surfaces so that the solenoid drivers are clustered together in a rather compact fashion. Solenoid drivers are each mechanically coupled to an associated print wire. The print wires are all arranged to converge at the front end of the housing where they are aligned along an

imaginary straight line and arranged in very closed spaced fashion. A jewel bearing mounted upon the front face of the housing effectively a low friction guiding means for the forward ends of the print wire as well as eliminating any frictional engagement between the forward ends of the print wires and the paper document which may otherwise occur even when the print wires are in the retracted position, due to the close spacing between the front face of the housing and the paper document.

The closely clustered arrangement of the individual solenoid drivers and the housing assembly provides an extremely compact light weight printer head assembly which is capable of being employed in high speed printers of the dot-matrix type and is adapted to operate at speeds not heretofore obtainable by conventional dot-matrix printers.

The solenoid assembly includes a circular shaped spring biasing member adapted to engage the interior surface of the solenoid assembly end cap which prevents the spring from being bent beyond its flat position when it strikes the interior surface of the end cap.

It is therefore one object of the present invention to provide a solenoid assembly for use in high speed printers of the dot matrix type in which the end cap prevents the armature biasing spring from bending beyond the flat position when the biasing spring engages the end cap as it returns to the rest position.

Another object of the present invention is to provide a novel solenoid driver assembly for use with impact printers of the dot-matrix type, which solenoid driver assemblies are of simplified design and rugged construction to permit high speed operation thereof.

These as well as other objects of the present invention will become apparent when reading the accompanying description and drawing in which:

FIGS. 1a and 1b are perspective views showing a printer head assembly designed in accordance with the principles of the present invention.

FIGS. 1c and 1d are top and side elevational views respectively of the printer head assembly of FIGS. 1a and 1b.

FIG. 1e is a front view of the printer head assembly showing the jewel bearings provided along the front face thereof in greater detail.

FIG. 1f is a perspective view showing the jewel bearing alignment tool which may be employed in the assembly of printer heads.

FIG. 2 is a sectional view of one of the solenoid drivers as shown in FIGS. 1a-1d whereby the internal structure of the solenoid is shown in detail.

FIGS. 1a-1c show the printer head assembly 10 which is comprised of a one-piece die cast core member 11 having a base portion 12 for mounting member 11 upon a movable carriage assembly (not shown).

The rear end of member 11 is provided with an upwardly projecting wall 14 having a plurality of tapped openings 15 (not also FIG. 1a). The rearwardly directed surface of wall 14 has a truncated pyramidal configuration. The openings 15 provided on the rear surface 15a are aligned so as to be substantially perpendicular to their associated mounting surfaces Opening 15', positioned in the truncated portion, is aligned relative to rear surface 15a in a substantially similar fashion so that the central axes for all openings except for opening 15' will intersect at a remote point, which point will lie on an imaginary line which is coincident

with the central axis of opening 15'. The purpose for this alignment will be subsequently described.

Each of the openings is tapped to threadedly engage the threaded collar 17 of a solenoid assembly 18. FIG. 2 shows a cross-sectional view of one solenoid assembly 18 removed from the assembly 10 in order to show the internal structure in detail. The remaining solenoid assemblies are similarly provided with threaded collars for threadedly engaging an associated one of the tapped apertures 15. Each solenoid has a slender solenoid wire 19 projecting outwardly through an opening provided at the forward end of each tapped collar 17, which print wires extend from the forward end of each solenoid assembly to the forward or left-hand end of member 11 in a manner to be more fully described.

Die cast member 11 is further provided with a first mounting portion 20 having a first groove 21 provided in a first upright portion 22 and a groove 21a provided in a second upright portion 24. The grooves 21 and 21a are adapted to receive a flat plate 25 provided with a plurality of openings 26, each receiving an associated one of the solenoid wires 19.

A second supporting section 27 die cast as an integral part of member 11 and positioned in front of section 20 is comprised of a first groove 28 extending from a first upright portion 29 and a second groove 28a provided in a second upright portion 30. These grooves are adapted to receive a flat plate 31 provided with a plurality of openings 32, each receiving an associated one of the solenoid wires 19.

A final upright portion 34 is die cast as an integral portion of member 11 and is provided with a centrally located opening 35, which opening widens at ledge 38 to form a wider opening 39.

In operation, the solenoid wires 19 may be selectively moved in the directions shown by arrows 40 and 41 (FIG. 1d) so as to selectively impact against a paper tape (not shown) positioned in close proximity to the front end of the printer head assembly. In order that the constant and rapid movement of the print wires be subjected to a minimum amount of abrasive wear, a plurality of tube guides 42 are provided. Each of the tube guides 42 is comprised of a hollow, elongated sleeve formed of a metallic material which is force-fitted through an associated opening 26 in disc 25 and which receives a print wire through its central opening so as to prevent any abrasive wear between the solenoid wires and the disc 25. The interior surfaces of each of the sleeves is lubricated preferably with a dry lubricant such as disulphide to reduce wearing due to frictional engagement to permit the solenoid wires to experience reciprocal movement within the stationary sleeves without experiencing any noticeable wear.

In order to prevent abrasive wear of the solenoid wires 19 by the plate 31, tube guides 42 are each of a length sufficient to extend from plate 25 to plate 31. The forward ends of sleeves 42 are force-fitted into associated openings 32 of the plate 31 and are further cemented with a suitable epoxy (not shown) to permit the solenoid wires to experience reciprocal movement within the stationary guides 42 and openings in plate 31 without experiencing any noticeable wear.

A pair of jewel bearings 44 are force-fitted into the enlarged opening 39 provided in upright section 34. The jewel bearings 44 and 45 are shown in detail in FIGS. 1a and 1e and are comprised of solid rectangular shaped members preferably formed of sapphire. The

adjacent vertically aligned sides of the jewel bearings are provided with a plurality of semicircular-shaped grooves 44a and 45a, respectively, such that each groove in jewel bearing 44 is aligned with an associated groove 45a in jewel bearing 45 to form a plurality of substantially circular shaped openings for receiving and guiding an associated one of the solenoid wires 19.

Jewel bearing 44 is positioned against the left-hand wall of opening 39, and is preferably secured thereto by a suitable epoxy. Jewel bearing 45 is positioned immediately adjacent jewel bearing 44 and is firmly urged toward jewel bearing 44 by means of a spring 46 positioned between the right-hand vertical side of jewel bearing 45 and the right-hand vertical wall of opening 39. Resilient spring member 46 preferably has a corrugated or serpentine configuration.

In order to provide for precision alignment of the jewel bearings 44 and 45, a jewel bearing alignment tool 47, as shown in FIG. 1f, may be employed. The aligning tool is positioned in front of upright section 34 so that its projecting pins 47a and 47b are inserted into the topmost and bottommost circular shaped openings, respectively, which are formed by the semicircular shaped grooves 44a and 45a, respectively, provided in the jewel bearings 44 and 45. With the jewel bearing alignment tool in this position, the bearings may be accurately aligned. Upon completion of their alignment, a suitable epoxy is applied to the region on both sides of spring member 46 so as to firmly cement the jewel bearing 45 into position. Once the epoxy sets, the jewel bearing alignment tool may be removed.

The printer head assembly design greatly simplifies the final assembly of the head which may be performed in the following manner:

The jewel bearings are aligned and cemented into place in the manner described hereinabove. The tube guides are force-fitted into associated openings within the plates 25 and 32, respectively. The plates are then positioned into their associated grooves 21-21a and 28-28a, respectively. The plates 25 and 32 are preferably cemented into place. The forward free ends of the solenoid wires 19 are first inserted through openings 15 (and 15') in rear wall 14, through rear guides 26, through rear guides 33 and bearings 44 and 45, and the threaded collars of solenoids 18 are screwed tightly into threaded engagement with tapped openings 15. Threaded nuts 51 are provided to align the forward ends of print wires 19 and to lock the solenoids 18 (and 18') into place, once adjusted.

The jewel bearings 44 and 45, which are preferably formed of a material such as, for example, sapphire, are likewise characterized by having a low coefficient of friction so as to cause no significant wear of either the jewel bearings or the solenoid wires as a result of reciprocal movement of the solenoid wires relative to the jewel bearings. The front faces of the jewel bearings also serve as a means for reducing abrasive wear between the forward ends of print wires 19 and the paper document (not shown) when the printer head assembly moves relative to the paper document. Such wear (in the absence of the jewel bearings) is due to the relative close spacing between the forward ends of the print wires (when retracted) and the paper document.

As an alternative assembly the members 44 and 45 may be replaced by a single jewel bearing member (not shown) having centrally located openings for receiving the forward ends of print wires 19.

The rear surface 14a of rear wall 14 is a truncated pyramidal shaped surface such that the solenoid members 18, when secured thereto, are all diagonally aligned relative to an imaginary vertical plane, except for the center solenoid member 18g which is aligned substantially perpendicular to an imaginary vertical plane. The solenoids 18a, 18b, 18e and 18f are aligned at an angle of approximately 20° relative to an imaginary vertical plane; solenoids 18a and 18b are aligned at an angle of approximately 30° relative to an imaginary horizontal plane; while solenoids 18c, 18d, 18e and 18f are aligned at an angle of approximately 20° relative to an imaginary horizontal plane; and solenoid 18d is aligned at an angle of approximately 20° relative to the imaginary horizontal plane. This alignment facilitates and simplifies the degree of bending the printer wires experience in converging toward a more or less bundled position in the region between upright support sections 25, 27 and 34 so as to guide the solenoid wires toward the jewel bearing members 44 and 45 with a minimum amount of bending or bowing thereof. For example, the wires of the topmost solenoid 18d, the bottom-most center solenoid 18c and center solenoid 18g all remain aligned substantially within an imaginary common vertically aligned plane and, therefore, undergo no bending in a direction transverse to said plane. The remaining wires undergo rather limited bending in the aforesaid transverse direction. This arrangement significantly reduces the space (i.e., volume) which the head assembly occupies, to thereby greatly simplify the complementary design of the printer apparatus using the printer head assembly.

The printer head components, when fully assembled in the manner described hereinabove, may be completely sealed by means of a plastic cover assembly 49 which is formed of a plastic material of sufficient resiliency so as to permit the pair of inwardly directed flanges 49a and 49b provided at the forward end of the cover to move slightly apart when snapping the cover assembly into position until the flanges clear the undersurface of base 12, at which time the flanges 49a and 49b snap into position so as to embrace the marginal edges of the undersurface and thereby firmly retain the cover assembly 49 upon the die cast member 11. A similar pair of flanges 49c and 49d are provided at the rearward end of the cover assembly 49 for embracing the undersurface of base portion 12 of die cast member 11 in the immediate region of rear wall 14. The cover assembly 49 may be simply and readily removed from member 11 by pulling the pairs of flanges 49a-49b and 49c-49d slightly apart until they clear the undersurface of die cast member 11, at which time the cover may then be lifted up and away from member 11 to provide access to the interior of the printer head assembly.

FIG. 2 shows a detailed sectional view of one of the print wire solenoids 18 which is comprised of a one-piece shell member 50 whose right-hand portion is substantially cylindrical in shape and is threaded at 17. A fastening nut 51 threadedly engages threaded collar 17 for the purpose of tightening or locking the solenoid to the upright wall 14 once the solenoid is mounted in the desired position. The left-hand portion of shell 50 is also cylindrical in shape and has a cylindrical wall 53 to form a hollow annular shaped interior region 54 which houses the solenoid coil 55. The central core portion 52 has a centrally located opening 56 for slidably receiving print wire 19 which is secured to the left-

hand end of cylindrical shaped armature member 57 and which passes through opening 56 to a wider opening 56a and a still wider opening 56b provided in shell 50. A tubular shaped wire guide 58 surrounds a portion of print wire 19, as shown. A suitable dry powdered lubricant is provided between the interior surface of wire guide 58 and print wire 19 and between the opening 56 and print wire 19 to minimize wear during reciprocating movement of the print wire. The solenoid coil 55 is provided with a pair of connecting leads 59 for coupling the print solenoid to driving circuitry. The connecting leads 59 extend through an opening 60 provided near the left-hand end of shell 50.

The armature member 57 which is formed of a permanent magnet material is secured to a circular shaped disc 61, formed of a springy or resilient metallic material, by means of rivet 62. A thin mylar wafer 63 is positioned between armature 57 and the left-hand surface of spring 61 and a second mylar wafer 64 is positioned between the right-hand surface of spring 61 and the head of rivet 62, to reduce vibration.

A relatively thick disc shaped member 65 having a central opening 65a is positioned within shell 50 and has a continuous annular shaped projecting flange portion 65b engaging the left-hand surface of spring 61. The armature assembly, including spring 61 and armature 57, as well as disc 65, is rigidly secured within shell 50 by means of a cap 66 having a tapped interior surface 67 which threadedly engages the threaded portion 68 of shell 50.

In operation, with the coil assembly 55 deenergized, spring means 61 assumes its flat shape, as shown in FIG. 2. Upon energization of coil assembly 55, the magnetic field generated by coil 55 urges armature 57 in a direction shown by arrow A against the biasing force imposed upon the armature by spring 61 thereby moving print wire. When the coil assembly 55 is deenergized, armature 57 is caused to return to the position shown in FIG. 2 under the influence of the biasing spring 61. The print solenoid is adjusted so as to cause the print wire to move approximately 0.45 to 0.56 millimeters toward the right when the coil assembly is energized, thereby causing the extreme left-hand end of the print wire to extend by the above-mentioned distance in order to impact a ribbon (not shown) and thereby print a dot upon a paper document supported by a platen (not shown).

The coil assembly is wound upon a cylindrical shaped bobbin 70 which is then inserted into the hollow annular portion 54 of shell 50.

The tubular shaped wire guide 58 has its left-hand portion secured to the interior opening 56a by means of a suitable epoxy. An epoxy is also preferably applied between the threaded portion 68 of shell 50 and the tapped portion 67 of cap 66 in order to firmly join the shell 53 and cap 66 after appropriate adjustment (i.e., tightening) of cap 66 upon the shell. A small opening 66a is provided at the center of cap 66 to adjust the amount of travel which the armature 57 may experience and to thereby control the amount of travel experienced by each print wire 19. The print wire solenoid assemblies, as well as the printer head assembly of FIGS. 1a-1e are formed of lightweight metals and the assembly is of such a compact design as to enable the assembly to move at a high rate of speed across the printer apparatus to provide extremely high speed printing operations. For example, in one preferred em-

bodiment, the printer head assembly is capable of moving at a speed which is sufficient to permit the printing of more than 165 characters per second. The solenoids are capable of being energized at a rate of the order of one thousand times per second under the control of energizing pulses of 0.4 millisecond pulse width. A detailed description of one such printer system which employs the printer head assembly described herein to great advantage is set forth in copending application Ser. No. 35,405, filed May 7, 1970, now U.S. Pat. No. 3,703,949, issued Nov. 28, 1972, and assigned to the assignee of the present invention.

It can be seen from the foregoing description that the present invention provides a novel and simplified printer head assembly in which a single die cast member is provided for mounting the printer solenoid, guiding the solenoid wires and providing a jewel bearing mounting which accurately aligns the solenoid printer wires in a precise vertical arrangement so as to greatly facilitate assembly of the printer head apparatus and provide for significantly reduced wear of the components.

Although this invention has been described with respect to its preferred embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art and it is preferred, therefore, that the scope of the invention be limited not by the specific disclosure herein, but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. Driving means for driving the print wires of printers of the dot matrix type being comprised of:
 - a housing having a central opening extending from the front to the rear of said housing;
 - a hollow annular shaped opening surrounding a rearward portion of said central opening;
 - an annular shaped coil assembly adapted to be energized by an electrical source being positioned within said annular-shaped opening and surrounding the rearward portion of said central opening;
 - a cylindrical shaped armature being positioned for

reciprocating movement within the rearward portion of said central opening so that at least a portion of said armature is surrounded by said coil assembly;

a flat circular shaped biasing member having its central portion secured to the rearward end of said armature;

a circular shaped end cap threadedly engaging the rearward end of said housing, said end cap having an interior surface engaging at least a portion of the flat biasing member when the biasing member is substantially in the flat condition;

means positioned within said housing near the rearward end thereof for engaging the periphery of said biasing member;

said biasing member being positioned between said positioning means and the interior surface of said end cap;

the rear end of the hollow cylindrical section of said housing which separates said central opening from said annular shaped opening being a spaced distance from the adjacent end of said armature to enable said biasing member to experience flexing when said coil assembly is energized to move said armature in the forward direction;

said biasing member normally urging said armature in the rearward direction when said coil assembly is energized to engage said end cap, whereby engagement of said end cap prevents said biasing spring from flexing rearwardly beyond its normally flat condition;

a thin elongated print wire having its rearward portion extending into said central opening;

the rearward end of said print wire being joined to the forward end of said armature to be driven in a reciprocating manner by said armature.

2. The driving means of claim 1 wherein said biasing member is a thin circular shaped disc formed of a resilient metallic material.

3. The driving means of claim 1 further comprising a fastening member for joining the central portion of said biasing member to the rear end of said armature.

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